

# CHAPTER V - APPLIED TROPICAL CYCLONE RESEARCH SUMMARY

## 1. JTWC RESEARCH

With the addition of the Southern Hemisphere to the JTWC area of responsibility, JTWC's applied research has been substantially reduced. The goal of JTWC's effort in the research area has been to improve the timeliness and accuracy of operational tropical cyclone warnings. During 1982, JTWC continued to pursue projects of merit as summarized below:

### WEIGHTED STEERING PROGRAM

(Allen, R.L.: NAVOCEANCOMCEN/JTWC)

A forecast position aid is currently under development which applies an empirically-derived bias to CYCLOPS unmodified steering prognostics. Preliminary results indicate that the 700 mb steering flow (with bias) is the best predictor of meridional motion and a biased average of 850 and 500 mb flow is the best predictor of zonal motion. Initial results from verification studies are promising; further investigation will be conducted during the 1983 tropical cyclone season.

### JTWC FORECASTER'S HANDBOOK

(Wells, F.H.; Edson, R.E.; Weir, R.C.: NAVOCEANCOMCEN/JTWC)

An ambitious project to accumulate, in one compendium, the practical information necessary for an operational tropical cyclone forecaster in the western Pacific and Indian Ocean regions.

### COMBINED TROPICAL CYCLONE FORECASTING AIDS

(Edson, R.E., et al: NAVOCEANCOMCEN/JTWC)

The project objective was to receive all FNOC tropical cyclone forecasting aids as the result of a single request. Several decoder problems were tested and corrected. Additionally, procedures were developed to automate execution of the Nested Tropical Cyclone Model when a tropical cyclone was in warning status.

### CLIMATOLOGY (CLIM) FORECAST AID UPDATE

(Edson, R.E., et al: NAVOCEANCOMCEN/JTWC)

The CLIM data base was updated through the 1981 tropical cyclone season. In the western North Pacific, five years of new data increased the data base by 16 percent. In the other JTWC regions, the data base was increased by 30 percent with the addition of 10 years of tropical cyclone best track data.

### TYAN OBJECTIVE FORECAST AID UPDATE

(Edson, R.E., et al: NAVOCEANCOMCEN/JTWC)

The TYAN data base for the Southern Hemisphere and the North Indian Ocean was updated through the 1981 tropical cyclone season, yielding a 30 percent increase in tropical cyclone positions. Procedures were developed to implement the annual update more efficiently. It was also recommended that the western North Pacific model classification of tropical cyclone tracks (RECR, STRA and TOTL) be modified to increase the model's resolution.

### CYCLOPS OBJECTIVE FORECAST AID UPDATE

(Edson, R.E.: NAVOCEANCOMCEN/JTWC)

In light of the recent development of dynamic tropical cyclone models, CYCLOPS could best serve the forecaster as a "plain" steering aid. This would require:

- Removal of the, sometime aberrant, persistence correction.
- Changing of the long wave filter to more accurately depict wave numbers.
- Testing the size/strength of the tropical cyclone for significance.

After testing for effectiveness with the NOGAPS global model, the updated CYCLOPS would be used in conjunction with the dynamic models to indicate expected steering flow at specific levels.

### NAVY OPERATIONAL GLOBAL ATMOSPHERIC PREDICTION SYSTEM (NOGAPS) EVALUATION

(Edson, R.E.: NAVOCEANCOMCEN/JTWC)

JTWC participated in evaluating the tropics portion of FNOC Monterey's new global model.

## 2. NEPRF RESEARCH

### TROPICAL CYCLONE STORM SURGE

(Brand, S., NAVENVPREDRSCHFAC; Jarrell, J.D., Compton, J., Science Applications Inc.)

A tropical cyclone storm surge evaluation has been initiated to establish the following: (a) the needs of the Navy in forecasting tropical cyclone storm surge in the western Pacific; (b) the state of the art of storm surge forecasting techniques; and (c) the best approach to solving the Navy's problems associated with tropical cyclone storm surge.

THE NAVY TWO-WAY INTERACTIVE NESTED  
TROPICAL CYCLONE MODEL (NTCM)

(Fiorino, M., NAVENVPREDRSCHFAC)

Testing of the NTCM concept continued throughout the 1982 season on two versions of the model - the current Cyber 175 version automatically run using the tropical NVA (global bands) analysis, and an improved model coded for the Cyber 205, (NTCM205) the results of which were clearly superior. The NTCM205 performance was markedly reduced when initialized with NOGAPS analyses compared to the NVA analyses. This discrepancy was attributed to a combination of NOGAPS initialization and data assimilation procedures and the high degree of NTCM sensitivity to the large-scale initial wind fields.

Testing will continue on the one-way influence lateral boundary conditions developed at the National Meteorological Center (NMC) which are designed to force outside-the-domain information into forecasts of a limited area model. Experiments will be conducted on expanding the domain of the NTCM Coarse Grid (the large-scale tropical model) to minimize the influence of the channel boundary conditions.

TROPICAL CYCLONE OPTIMUM FORECAST AID

(Tsui, T., NAVENVPREDRSCHFAC)

A comprehensive review of the performance of all JTWC objective tropical cyclone forecast aids has shown that during 1979-1981 --- if JTWC could have selected the "correct" or the "optimum" forecast aid every time --- the average forecast error could be reduced to 71, 119 159 nm (132, 220, 295 km) for the 24-, 48-, and 72-hour forecasts respectively. The question remains as to which technique is the optimum aid for each situation.

A full-scale test of the optimum-aid concept is now underway. The logical first step of this study is to assess the strength and the characteristics of each objective forecast aid.

TROPICAL CYCLONE OBJECTIVE FORECAST  
CONFIDENCE AND DISPLAY TECHNIQUE

(Tsui, T., NAVENVPREDRSCHFAC; Nuttal, K., Systems and Applied Sciences Corp.)

In July 1982, forecasters at JTWC could operationally issue a single ARQ command to activate all 11 objective tropical cyclone forecast aids for North Pacific tropical cyclones.

When the system is completed in 1983, a weighted combined tropical cyclone forecast composed from all available objective aids will be issued upon each combined ARQ request. The weights of the combination are deduced from the past (1979-1981) performance of the aids.

SPEED OF RECURVING TYPHOONS

(Sadler, J.C. and B. Cheng-Lan  
University of Hawaii)

Western North Pacific tropical cyclone data were evaluated to determine the characteristics of recurving typhoons, near and after the time of recurvature, during the 10-year period 1970-1979. Three recurving typhoons which produced large forecast errors after recurvature were selected for case studies in search of aids for anticipating the acceleration in speed of movement after recurvature. Analyses of the upper-troposphere poleward of the typhoons revealed a good relation between the future storm speed and the averaged wind speed between 500 and 200 mb, observed, at and 12 hours prior to recurvature, along the future storm track.

SATELLITE BASED TROPICAL CYCLONE INTENSITY  
FORECASTS

(Cook, J. and Tsui, T., NAVENVPREDRSCHFAC;  
F. Nicholson, Systems Control Technology)

Software development is currently underway, for implementation on the NAVENVPREDRSCHFAC Satellite-data Processing and Display System (SPADS), to enable study of cloud structures in the newly developed spherical - spiral coordinate system. A Fourier analysis is performed on the cloud structure in spiral space with various harmonics correlated with atmospheric parameters.

Also under investigation is a method of studying the relationship between cyclone intensity and IR radiances/patterns in Lagrangian coordinates. Satellite images of tropical cyclones are rotated and the image parameters are correlated with the cyclone intensity and rate of intensity change.

TROPICAL CYCLONE INTENSITY FORECAST

(Tsui, T. and Cook, J., NAVENVPREDRSCHFAC;  
Hamilton, H., System and Applied  
Sciences Corporation)

A study of the western North Pacific tropical cyclone intensity forecast program (MAXWIND) showed that two synoptic parameters -- the central equivalent potential temperature and the large-scale vertical wind shears -- correlate highly with the intensity change. Efforts have been initiated to quantify the relationships between: (1) the equivalent potential temperature and the central sea surface pressure when below 999 mb; and (2) the NOGAPS large-scale vertical wind shear and the tropical cyclone intensity change.

TROPICAL CYCLONE GUST AND SUSTAINED WIND  
FORECAST AIDS FOR YOKOSUKA AND CUBI POINT

(Jarrell, J.D. and Englebreton, R.E.,  
Science Applications Inc.)

Forecast aids were developed for predicting wind conditions at Yokosuka and Cubi Point when a tropical cyclone passed within 360 nm (667 km). The forecast aids were produced by analyzing a data set comprising the ratios of station wind values to tropical cyclone center wind values. Ratio values were then assigned to the position of the cyclone center. The 360 nm (667 km) radius circle about the station was divided into 71 equal area segments and the values of the mean and maximum ratio within each segment were subjectively analyzed to produce the forecast aids.

TROPICAL CYCLONE STRIKE AND WIND PROBABILITIES

(Brand, S., NAVENVPREDRSCHFAC; Jarrell,  
J.D., Science Applications Inc.; Chin,  
D., Systems and Applied Sciences Corp.)

Tropical cyclone strike and wind probability is a method for determining up through 72 hours that a tropical cyclone will affect geographical points of interest to the user. Applications presently being developed, tested and implemented for the western North Pacific, North Indian Ocean, western North Atlantic, and Gulf of Mexico include: strike/wind probabilities and geographical depictions; optimum track ship routing (OTSR) aids; HP-9845/Tactical Environmental Support System (TESS) software for shipboard environmentalists and decision makers; terrain adjusted probabilities; and condition setting aids.

3. PUBLICATIONS

Diercks, J.W., R.C. Weir and M.K. Kopper,  
1982: Forecast Verification and  
Reconnaissance Data for Southern  
Hemisphere Tropical Cyclones.  
NAVOCEANCOMCEN/JTWC TECH NOTE: NOCC/  
JTWC 82-1.

The Joint Typhoon Warning Center (JTWC) area of responsibility now includes the Southern Hemisphere, from 180° longitude westward to the east coast of Africa. This technical note documents forecast verification and reconnaissance data for those Southern Hemisphere tropical cyclones that occurred between 1 July 1980 and 30 June 1982.

Weir, R.C., 1982: Predicting the Acceleration of Northward-moving Tropical Cyclones Using Upper-Tropospheric Winds.  
NAVOCEANCOMCEN/JTWC TECH NOTE: NOCC/  
JTWC 82-2.

Inconsistent forecasting of the acceleration of northward-moving tropical cyclones entering the domain of the mid-latitude westerlies has been a long-standing weakness in tropical cyclone forecasting. The tracks of tropical cyclones traversing a relative high-density data area of the western North Pacific have been analyzed to verify the acceleration phenomenon, and to correlate the movement with features of the upper-tropospheric wind field. The resultant forecast technique is described and the results obtained with its use during the 1982 tropical cyclone season in the western North Pacific are presented.